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[54] IMPROVED MOISTURE-RESISTANT COATING AND METHOD OF PRODUCING IT

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[57] ABSTRACT

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## DETAILS

### PATENT SPECIFICATION

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### COMPLETE SPECIFICATION

Improved Moisture-Resistant Coating and Method of Producing it We, WESTERN ELECTRIC COM Pi ANY INCORPORATED, of 195, Broadway, New York City, New York State, 'United States of America, a Corporation of the State of New York, tnited States of America, do hereby declare the nature of this inven-tion and in -what manner the same is to be performed, to be particularly described and ascertained in and by the following statement: -

This invention relates to a coating pro-cess for producing a moisture-resistant coating on a metallic or non-mietallic sur-face.

In its preferred embodiment the inven-tion is particularly applicable to electrical devices such as transformers, retard coils and the like In protecting such a device from the adverse effects of moisture it

has generally been customary to place the device within a hermetically sealed metal container filled with a suitable potting compound. However, there are many instances, such as in airborne or portable equipment, where the additional weight of the container and the potting compound and the resulting increase in size are objectionable.

It is an object of the present invention to provide such a device with an adherent moisture resistant coating which will maintain its characteristics over a wide temperature range.

According to the invention a method of forming a smooth adherent moisture-resistant coating on a surface such as the external surface of an electrical device comprising a formed coil comprises applying to the surface an impregnating coating consisting of a polymerizable resin varnish, drying and baking said coating until the varnish is substantially fully cured, subsequently applying to the surface a final coating of a polymerizable resin varnish containing a suitable amount of a finely divided inert inorganic filler, and then drying and baking said final coating for a time and at a temperature sufficient to solidify the resin in said coating but insufficient to produce the complete curing of said resin in said coating.

The invention will be better understood by reference to the following detailed description and the accompanying drawing in which the figure represents one type of electrical device which is provided with a moisture-resistant coating in accordance with the process of the present invention.

The power transformer disclosed in the drawing is of the usual type comprising a closed laminated core with the coil forming the primary and secondary windings surrounding one leg of the core and with the coil completely surrounded by a spiral wrapping of an insulating tape of muslin, for example.

The present invention is concerned with the provision of a moisture-resistant coating for such a device, which coating will be substantially moisture-proof even when the device is subjected to water immersion and which will maintain its moisture-resistant properties over a wide temperature range, such as from  $50^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The preferred procedure for applying a moisture-resistant coating to a transformer of the type disclosed in the drawing will now be described.

After the transformer has been thoroughly dried by baking in a vacuum for several hours at a temperature of  $230^{\circ}\text{F}$  the transformer is immediately placed in an unheated tank and maintained under a vacuum while cooling from the baking temperature. An impregnating coating comprising a polymerizable varnish, is then drawn into the tank to cover the transformer completely while still maintaining a vacuum in the tank.

The vacuum in the tank is maintained for several minutes after which the vacuum is broken and the transformer retained immersed in the impregnating compound for a further period, forty-five minutes for example. The transformer is then removed from the tank, is air dried and drained at room temperature for one hour and is then baked at a temperature of  $270^{\circ}\text{F}$  for 8 to 10 hours, or until the polymerizable material in the impregnating compound is substantially fully cured. This impregnated transformer is then allowed to cool in the evacuated tank after which the transformer is given a second impregnation with the same impregnating compound in accordance with the same procedure described for the first impregnation including, as a final step, baking at the same temperature and for the same length of time.

COATING.

The doubly impregnated transformer is then given two coatings of a uniform mixture of a coating compound, comprising a polymerizable varnish and finely divided talc (magnesium silicate) in the proportions of 3.5 pound of talc to 4.1 pound of the resin content of the varnish.

The impregnated transformer is first completely immersed in the coating compound, for a substantial period and for at least ten minutes after which the transformer is withdrawn, drained and air dried at room temperature for 5 or 6 hours, followed by slowly baking the coated transformer for a period of 10 hours at a temperature of 209 F + 100 F.

The coating transformer is again completely immersed in the coating compound for at least ten minutes after which it is withdrawn, drained and air dried at room temperature for 5 or 6 hours, followed by slowly baking the coated transformer for a period of 11 to 12 hours at a temperature of 209 F + 10.° F.

The period of air drying at substantially room temperature prior to the baking at an elevated temperature is desirable to facilitate the evaporation of the thinner or solvent of the varnish before the coating compound has become hardened. The relatively slow rate of partial curing of each coating is desirable to complete the driving off of the volatile thinner at such a slow rate as to prevent the formation of the coating of voids or holes which if present would result in reduced resistance of the structure to moisture penetration.

It is preferable that the same varnish be used as the impregnating compound and in the coating compound. One varnish which has been found quite satisfactory for both the impregnating compound and the coating compound is "Harvell 612 C" varnish manufactured by the Irvington Varnish and Insulator Company. This commercial varnish may be used unchanged in the coating compound but it is generally found advisable to add a small amount of thinner, such as petroleum naphtha, to the varnish when it is to be used as the impregnating compound. This Harvell varnish comprises the condensation product of formaldehyde and the oil of the cashew nut shell (which contains a phenolic component) dissolved in a suitable solvent, such as petroleum naphtha, the varnish having a solid content of 57 per cent + 2 per cent. However, other heat reactive polymerizable varnishes having a low oxidation rate when exposed to air may be employed in the process of this invention.

Purified talc is the preferred finely divided inert inorganic filler to be added to the varnish to form the coating compound. The talc may be either fibrous or amorphous although the amorphous form is preferred. Grades of talc have been obtained when the talc is such that it will pass through a 200 mesh screen, United States standard specification. Talc is particularly advantageous because of its low temperature coefficient of expansion, and because its relatively low density enables it to be uniformly suspended in the varnish. Talc is also desirable because of its good wetting characteristics in varnish and its poor wetting characteristics in water. However other finely divided inert powders of low temperature coefficient of expansion may be employed in place of talc, such as sand, mica, asbestos, aluminum silicate and chalk. In order to achieve the best results in making the coated transformer moisture-resistant, it has been found that the amount of talc employed in the coating compound is somewhat critical. It is preferred that the varnish and the talc be mixed in such proportions that the weight of the talc is 5-15 per cent of the weight of the solid content of the varnish. However good results will be obtained if the weight of the talc lies within the range from 50 per cent to 90 per cent of the weight of the solid content of the varnish. In any event, the weight of the talc used in the coating compound should be less than the weight of the solid content of the varnish.

The amount of the inert filler employed in the coating compound depends upon the density of the filler. When the following:

fillers are used in the coating nominal 125 in place of the weight of each substituted filler in the mixture as compared to the weight of the solid content of the varnish should be as follows:- Per cent characteristics even when subjected to such wide temperature variations that would cause a fully cured coating to crack.

In order to distinguish more clearly from the partial curing of the varnish-88 to 98 filler coating and the full curing of the varnish impregnations, it may be stated that for each varnish-filler coating the baking is for a time and a temperature such that the coating while solid is still at the con thermoplastic, the resin has not reached coating mix the stage of infusibility and the resinous reducing the material is still soluble in its original coating solvent; while for the full curing in the referred con impregnations the varnish is made in-conds when fusible, is no longer thermoplastic and is ) with a 20 insoluble in its original solvent 80 h A S T M After the transformer has had applied clear lacquers thereto two coatings of the varnish-filler shed ill 1942 mixture a subsequent inspection will dis-ty of Testing close no line of demarcation between the f the thinner first coating and the second coating The 85 ated or addi two coatings appear as a single coating this re(quire alld it is impossible to strip off the second coating from the first coating Since at ins and the the time the second coating is applied the loyed depend resin in the first coating is still in a par 90 configuration tially soluble state, it is likely that the and the tem surface of the first coating is softened evic may be somewhat by the solvent in the second a small size coating to co 6 alesce the two coatings into a imenesions of unitary coating as the result of the final 95 nchles of the baking.

awing, it has It has also been found preferable to apregnations achieve the partial curing of the resin in sirable when the coating compound at a relatively slow at the device rate, that is, by using a relatively low 100 ire proofing laking temperature for a (considerable temnl)erature lengthi of time rather than by baking at a to +12 A-3 ° C higher temperature for a, shorter time In -are found 1)articular for the first coating of varnish o should be andl talc the preferred baking is at a tem 105 d for a time perature of 19 W O F for a period of 5 hours, above in the although the same anmount of partial than the one curing M-ay be obtained at a baking tem-two coatings perature of 180 F for 8 hours or at a Yen for small baking temperature of 210 ° F for 4 hours 110 tings may be For the final coating of varnish and talc r instalnces to the preferred baking temh)erature is re resistant 190 F for a period of 12 hours although the same amount of partial curing may be the baking attaiad at a bakting teniperature of 1800 116 is that while F for a period of 1,5 hours or a baking -levic in the temperature of 2109 F for a period of 10 1 y cured, the lhours, andl a proportionate number of ating steps is hours for other temperatures between s, the baking 2100 F and 1800 F 120 ttion of the It should also be noted that each coat-such that the ing applied prior to the final coating is is only par baked for a much shorter length of tilne flexible coat than the final coating; this is because the tings are pro bakling of the final coating also increases 125 ags produced the amount of curing of the earlier coat-is been found ings and the total baking to which an istant eharae inner coating is subjected should not be Finely divided sand or silica Finely divided mica - Finely divided asbestos - Finely divided aluminium silicate Finely divided chalk - It has also been found tlh sisteucy of the varnish-filler ture is somnewhiat critical in pm best results At the time the pound is ready for use, its pi sistency is of 49 seconds + 4 s measured in ain A S T M cur inch, hole in accordance wit method D-333 for testing cl and lacquer enamels as publi in Part II of Americall Sociel Materials Standards Part o:

in the varnish may be evapor tional thinner added to meet mle iit.

The number of imupregnati number of coditings to be empl somewhat upon the size anbrd of the device to be protected -perature ranlrg to which the d subjected in service With transformer having over-all cl 4 inches by 4 inches by 4 i configuration shown ini tlbe dr been foundl that multiple i T and multiple coatings are de the requirements are such th must illailntaill its mlooisti characteristics over a wide range, sutch as from 55 ° C.

If more than two coating, desirable, the final coating baked at time temperature an interval the same as specified first coating. For coils larger assumed above, more than will generally be desirable; e size coils more than two coil found advantageous in many obtain increased moisture:

characteristics.

An important feature of treatments above described the varnish applied to the two impregnating steps is full varnish applied in the two coils only partially cured; that in temperature and (the duration baking for each coating are in content of the coating fully polymerized whereby coils are not hard brittle coating. With flexible coating in this manner, the device is to maintain its moisture-resistance sufficient to fully cure the resin of the inner coating.

The transformer disclosed in the drawing illustrates the device after it has been subjected to two impregnations followed by two coatings as described earlier in this specification. It is assumed that the varnish applied to the first impregnation is almost entirely absorbed by the coil form 2 and the muslin tape 3, while forming a thin coating 4 on the metal core 1.

For the second impregnation it is assumed that not all of the varnish is absorbed by the coil but some of it forms a coating external to the muslin tape 3. The inner coating and the outer coating of the varnish-talc mixture are indicated by the reference characters 6 and 7. The various terminals 8 for the transformer are shown after the varnish and (varnish-talc coatings) thereon have been removed. It is of course to be understood that in the drawing the thickness of each varnish or varnish-talc coating has been somewhat exaggerated. From the disclosure in the drawing it will be apparent that the smooth glassy-like moisture-proof coating produced by this invention extends not only around the coil of the transformer but also completely covers all metal parts of the transformer and the leads, resulting in a continuous coating surrounding the whole structure.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:- 1 The method of forming a smooth and moisture-resistant coating on a surface such as the external surface of an electrical coil in a form (coil, which method comprises applying to the surface, an impregnating coating consisting of a polymerizable resin varnish, drying and baking said impregnation coating until the varnish is substantially fully cured, subsequently applying to the surface a final coating of a polymerizable resin varnish containing a suitable amount of a finely divided inert inorganic filler, and then drying and baking said final coating for a time and at a temperature sufficient to solidify the resin in said coating but insufficient to produce the complete curing of said resin in said coating.

42 The method according to claim 1 in which the filler of the final coating is finely divided talc combined with the resin varnish in such relative proportions that the weight of the talc is 80 per cent, to 90 per cent of the weight of the solid content of the varnish.

3 The method according to claims 1 or 65 in which the final coating is dried at substantially room temperature and then baked at a temperature of 180 ° F to 210 ° F for a time of fifteen hours for a temperature of 180 ° F of ten hours for a temperature of 210 ° F and a proportionate number of hours for a temperature between 210 ° F and 1800 ° F.

4 The method according to any of claims 1 to 3 in which the impregnating coating comprises a solution of the reaction product of a cashew nut shell oil and an aldehyde and is dried and baked at a temperature of 200 ° F for a time of eight to ten hours; The method according to claim 1, 2

and 4 in which tile final coat-ing of varnish 1 N 1 ( 1 talc is applied in two layers, the first layer being dried at room temperature and then baked for a period of five hours at a temperature of 190 ° F.

to 21 ( O ' F, tile second layer being dried at 1 r 0011 temperature and then baked for a period of twelve hours at a temperature of 19 ( O ' F to 219 ( F 90 6 A device having a surface coated by tile method according to claim 1 with an inner impregnating coating, of a resin cured to an infusible insoluble state and an outer coating of an incompletely 95 thermally cured resin containing a finely (livide) inorganic filler.

7 A device completely encased in a protective resinous coating on its external surface produced by the method according to 100 claim 1 rendering it resistant to moisture penetration even after exposure to widely varying temperatures, said resinous (coat-in composition) comprising all inner impregnating layer of a polymerizable resin polymerized 105 to an infusible state and an outer coating of a polymerizable resin having dispersed therethrough a finely divided inorganic filler in an amount not greater than the weight of the resin in said outer coating but not less than 80 per cent by weight of the resin in said outer coating, said outer resin coating being thermally cured to a state in which it is flexible solid but is still fusible 116 8 Methods of coating surfaces substantially as herein described.

Dated this 1 st day of August, 194 G.

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